The importance and value of urban forests as climate changes

GM Moore

Burnley College, The University of Melbourne,
500 Yarra Boulevard, Richmond, Victoria, 3121

Abstract

The aesthetic value of trees in the avenues, boulevards, parks and gardens of Australian cities is often widely appreciated, but their economic value is often under-valued. Trees provide services and fulfil functional roles in cities. They are significant components of urban infrastructure and have a real and calculable economic value. An urban forest of 100 000 trees can save $1million per annum because their shade reduces electricity consumption. Shade can prolong the life of tarmac, and carbon is sequestered as the trees grow. A single large tree growing in a school may provide the equivalent shade of four shade sails, returning a value of about $2000 per annum, while five trees can stabilise a steep suburban block which would otherwise require about $50 000 of engineered piling to secure building insurance. Calculation of the economic contributions of trees can change the economic algorithms upon which decisions are made in cities. (*The Victorian Naturalist* **129** (5) 2012, 167–174)

Keywords: urban trees, climate change, economic value, ecological services, carbon sequestration

Introduction

Mature trees are significant assets to our environment and our society regardless of where they occur or whether they are native or exotic. A great deal of effort has gone into establishing, managing, conserving and preserving them. Considerable human labour and time have been expended on the trees as well as real energy in the form of fossil fuel that has underpinned their maintenance. Significant quantities of water have been allocated to their growth and development. They are community assets in every sense. Society has invested resources in their establishment and management, and they have matured as assets and are providing many and diverse benefits to society in return (Moore 1997).

While costs, damage and nuisance values attributed to trees are widely known, the benefits they provide are often subtle and under-appreciated. A monetary value should be assigned to trees using an acceptable amenity tree valuation formula. This value raises the status of the tree to that of an asset, and allows for the proper recognition of trees in the decision making processes.

There are also benefits that the urban forest provides for improving human health, extending life spans, reducing violence and vandalism, lowering blood pressure and providing economic savings on medical and social infrastructure costs (Tarran 2006; Tapper 2010). Tapper (2010) notes that use of water during heat waves could reduce ambient temperatures by both surface evaporation and transpirational cooling, and that such cooling could reduce the number of extra deaths that occur, particularly among elderly people. In its submission on water use, the Victorian Department of health noted that one of their objectives was promoting health and wellbeing outcomes through promoting the use of alternative water resources such as stormwater to maintain green spaces, thereby enhancing physical activity and liveability (Dedman 2010).

Cities are biodiversity hot spots (Daniels and Tait 2005) due to the variety of habitats that are available in public and private open space. In the past decade, tree populations in many Australian cities have declined, particularly with the loss of private open space (Mullaly, 2000). At a time of climate change, it is worrying that both private and public open spaces are threatened by urban renewal and development, which puts at risk long-term sustainability (Moore 2009). In many of these situations there is insufficient open space—public or private—for the planting of large trees and so the opportunities for the role of vegetation in ameliorating the heat island effect, reducing wind speed, providing shade and reducing energy use are reduced. This outcome raises questions about the economic viability of such developments, as well as their long term environmental sustainability.

The impact of climate change on urban trees

Many parts of south eastern Australia recorded below average rainfall for the 14 years between 1997 and 2010. There have been major storm events (often described as 'one in a century' or 'one in 50 year' events) annually and sometimes two or three times annually in most States in each of the years 2005 to 2010 inclusive. There has not been a similar dry period in recorded history and the frequency of major storm events has increased. These events are consistent with climate change models and they are likely to become a permanent part of our environmental conditions (Table 1).

Regardless of how things eventuate, the possibility of more permanent global climate change is altering the environments within which trees are growing. Such changes are also resulting in the rapid change of the political, economic and social environments within which tree managers operate, and the decision making processes that ensue (Moore 2006). There will be more severe weather events more often in south-eastern Australia, which will be associated with stronger winds and more intense rainfall (Table 2).

Such changes will have profound impacts on urban tree managers. Increased storm events,could see higher rates of windthrow and major branch failure. In recent storm events there have been lengthy and widespread power outages, often caused by falling trees and branches. These events should have been used to inform management practices that might be appropriate under a changed climate scenario, where the undergrounding of utility services, particularly in areas of high population density, should be adopted immediately (Moore 2009).

It has long been argued that undergrounding utility services is cost effective if installation and long-term maintenance costs are considered. However, installation and maintenance are often done by different sectors. In some States, installation is by private energy providers and tree maintenance by private land owners and local government, but in other States installation is by State Governments and maintenance by local governments and there are even greater numbers of entities involved. Australian society cannot afford such an economically and environmentally unsustainable regime.

Recent and tragic bushfires in New South Wales, Canberra and Victoria have raised many concerns about tree management and infrastructure. The findings of the Victorian Royal Commission into the 2009 bushfires recommended the undergrounding of electricity services in fire prone regions (Anon 2010). However, the above ground cabling has been replaced, just as it was, and the opportunity for a modern, safer, underground system appears to have passed.

The value of services provided by urban trees

Urban trees and landscapes are assets that require the expenditure of resources on their proper management. Questions that might be asked are: 'What is the value of the benefits that are provided by trees?' Or perhaps 'What does society get in return?' This paper deals with a number of functions or services that are provided by urban trees and calculates the economic value of that function or service.

In this paper, the economic value provided by an urban forest population of 100 000 mature trees is used as the basis of calculations. The number of 100 000 was chosen because such discussions are often about the number of mature trees managed by a single municipality. In other instances, values associated with individual trees are determined. All values have been calculated in Australian dollars (AUD) and at the time of writing, an Australian dollar is worth approximately 1.02 American dollars.

The value of shade from savings in electricity and water

The shade provided by trees can lower ambient temperatures by up to 8°C, reducing air conditioner use and carbon emissions. Estimates put the electricity savings at between 12 and 15% per annum. Manchester University's Adaptation Strategies for Climate Change in the Urban Environment Project found that increasing green space in cities by 10% reduced temperatures by 4°C, due to water evaporating from vegetation into the air (Fisher 2007). One of the major economic benefits of shade in the context of the Australian climate is reduced air temperatures that then reduce the use of air conditioners. This not only saves on electricity use but, since much of the power in Australia is generated by coal, also reduces carbon emissions (Fisher 2007).

Table 1. Current data trends on global warming and predictions of the likely outcomes for climate and sea level related changes (modified from Moore 2009).

FACTOR	HOW WE ARE TRACKING	PREDICTION
Global temperature	The last 30 years have been the warmest of the past 200 years	Suggests that temperature rises will be at or above the worst case scenario of 6–8°C
Australia terrestrial temperatures	Have increased by 1°C in the past 50 years	Is in line with higher rather than lower temperature predictions and a rise of 4°C is likely
La Nina Events	The last two years 2010-11 and 2011-12 were La Nina years and wet	2011 was the warmest La Nina event of the past 150 years and rainfall is still trending down
Drought in Victoria	After 14 below average rainfall years the past two have been above average	There will be an increased drought frequency for the State — likely to be 3–4 more droughts than over the past century
Sea levels	Have risen by 3 mm per annum for the past 15 years	Consistent with higher sea level predictions of greater than 60 cm
Global ocean heat	The heat content of global oceans is rising and it embodies massive extra energy	Consistent with temperature rises at or above the worst case scenario of 6–8°C
Atmospheric CO_2 levels	CO_2 levels for 2011 are at 390 ppm, the highest level for the past 1000 years	These are above the predicted worst case scenario and could exceed 1000 ppm
Safe atmospheric CO_2 levels	The environmentally safe level seems to be about 350 ppm, and for the past 200 000 years they have been at about 280 ppm	Atmospheric CO_2 levels are likely to rise to between about 500 and 1000 ppm, which could cause a major extinction event
Arctic ice cap	Melting more rapidly than expected. It seems the northern hemisphere is warming more rapidly than the south	Could melt as early as 2015 rather than 2040-2050 as was originally predicted
Melting polar ice caps	Melting more rapidly	Only 3% of the extra energy absorbed in global warming has gone into heating the atmosphere. Most has gone in melting the ice caps
Reflection of radiation by ice caps	As they diminish in size, less radiation is reflected from earth	Heating of the planet will accelerate to, or above, the worst case scenario

In the State of Victoria, where most of the State's electricity is from brown coal generation, this reduction in emissions is significant. Furthermore, in the generation of electricity from brown coal approximately 100L of water is used in the production of 1.0 kWh of electricity (Fisher 2007). So the shade provided by trees can also generate a saving of water that can be valued (Table 3). The shade from each tree saves 30 kWh of electricity per annum so an urban forest of 100 000 trees saves some 3 million kWh per annum. The combined savings from reduced electricity and water use are close to $1 million per annum.

The value of carbon sequestered in an urban forest

Mature trees are significant sinks of carbon, sequestering atmospheric carbon dioxide for long periods. The amount of carbon sequestered in a mature urban tree is not easy to determine accurately, but estimates can be made (McPherson 2007). Moore (2006) estimated the amount of carbon in a mature tree of 100 t total fresh weight for foliage, trunk and root system at approximately 10 t. However, these estimates can be revised as it is more likely that in older woody trees there is about 13 t (assuming 20% dry weight, with carbon constituting some 65% of the dry matter).

Table 2. Likely outcomes from climate related changes in south eastern Australia.

- Generally warmer winters and hotter summers
- A more tropical climate extending southward
- More easterly winds leading to summer storms
- More frequent major storm events
- More days of extreme fire risk weather
- More bushfire prone regions, extending to peri-urban parts of major cities
- Changed weather and fire patterns
- Fewer frosts, and in some places elimination of frosts completely
- Many more days above 30°C and double the number of days above 35°C
- Higher summer rainfall with more intense rainfall events
- Flooding of lowland coastal areas – probably minor
- For every one degree that temperatures rise, the snowline rises 100 m
- Agricultural productivity will change, in some cases improving
- Some crops will not be grown but others will become viable
- Housing and building construction processes will change
- Energy demands and patterns of use will alter

The value of the carbon sequestered can then be calculated using the current value of carbon per tonne established by the Australian carbon tax — $23 per tonne. There is debate about the validity of this value but it will be maintained until 2015, and it has been predicted that the price should be closer to $30 per tonne and could double over the next few years (Garnaut 2011). Using estimates for 100 000 mature trees, there are about $30 million worth of carbon sequestered (Table 4). To calculate the amount of carbon dioxide sequestered, multiply the weight of carbon by 3.67.

The cost of pruning for overhead utility cables
The calculations used to determine the value of carbon sequestered can be applied to the effects that pruning mature trees for construction and the installation of utility services, such as powerlines or communication cables, might have on carbon sequestered (Table 5). Different pruning regimes remove different proportions of the canopy, and so data for 30, 20 and 10% canopy reductions are shown. Given that pruning contracts and operations managed by local governments usually involve hundreds of trees, it is worth estimating overall carbon losses for pruning 100 trees (Table 5). These values could affect the economic value of pruning as a management tool, and could see the undergrounding of services, especially when the costs for three and five year pruning cycles are calculated.

Similar calculations can be applied to root damage and loss when roots are severed for construction and utility installation. There is growing evidence that there has been a general and significant undervaluation of carbon fixed below ground by mycorrhizae and microbes associated with plant root systems. Values for tree related carbon are likely to be considerably higher than any of the algorithms currently in use have so far revealed.

The value of shade in prolonging the useful life of bitumen in a tree lined street
Bitumen is a super-cooled liquid mixed with solvents, which can evaporate under the hot conditions typical of south-eastern Australia. This renders the surface of the tarmac crumbly as the asphalt degrades and reduces the useful life of the pavement. The presence of shade from trees can increase the useful life of asphalt pavement by at least 30%, but there are estimates that prolonged shade from trees can double or triple the useful life of bitumen pavements (McPherson and Muchnick 2005).

In this paper, it is estimated that a mature tree canopy with a spread of about 6 m radius provides some 113 m^2 of shade. If the shade from 33% of the canopy affects bitumen below the tree, then this represents an area of 37.3 m^2. The estimate of value is based on the premise that the life of shaded bitumen is extended by 50% from 20 years to 30 years (Table 6). It is conceded that small patches of shade do not represent real savings and it is only when extensive contiguous shade occurs that the savings are realised in the prolongation of the useful life of the bitumen. This is more likely to occur for pavements along narrow tree-lined streets and so the value of shade for a tree lined street 500 m in length, lined on each side by 50 mature trees has been calculated (Table 6).

The role value of trees in roadside reserves
Governments, through their agencies, are still major clearers of trees, forests and ecosystems.

Table 3. Economic value of shade from an urban forest of 100 000 trees.

Approximations used	Value
Number of trees in the urban forest population	100 000
Electricity saving due to shade per tree per annum (kWh per annum)	30
Total electricity saving per annum (kWh)	3 million
$ value of electricity per kWh	0.17
Total $ value of electricity saving per annum	510,000
$ value of savings in electricity use per annum for one tree	5.10
Water saved by reduced electricity use at 100 L per kWh (L)	300 million
Total $ value of water saved at $1.50 per kilolitre per annum	450,000
$ value of savings in water use per annum for one tree	4.50
Total $ value of savings in electricity and water use per annum	960 000

Table 4. Carbon fixed in urban forest of 100 000 trees.

Approximations used	Value
Number of trees in an urban forest population	100 000
Average weight of whole tree - above and below ground (tonnes, t)	100
Water content (%) of tree (approximation)	80
Dry matter mass of trees (%) (varies, so conservative estimate)	20
Carbon content of dry matter (%) (varies, so conservative estimate)	50
Amount of carbon sequestered in each tree (t)	13
Total carbon sequestered in an urban forest of 100,000 trees (t)	1 300 000
Total carbon dioxide sequestered in 100 000 trees (t)	4 771 000
$ value of carbon sequestered by 100 000 trees at $23/t	29.9 million

In most States, approaches to roadside vegetation at a time of climate change are inappropriate. Trees and roadside ecosystems are assets that fix carbon, provide shade, filter air, protect from wind, and provide wildlife corridors and habitat just to mention a few of their benefits. It is to be hoped that these benefits are properly costed for road-related projects where a balance of safety, cost and the environment has to be achieved.

However, roadside vegetation is still being cleared right across the country, despite the fact that it sequesters massive amounts of carbon that could be used to partially offset the carbon produced by the vehicles that use the roads. An old-fashioned and inflexible engineering philosophy about trees and the environment is no longer an appropriate paradigm at a time of climate change. It is clear that often the real and full economics of the situation are not properly considered.

Furthermore, in Britain, an $122 000 scheme to plant trees increasingly closer to the roadside verge is part of a $2.5 million scheme to reduce speed and improve safety (Lister 2010). Trees are also planted at so-called 'lazy diagonals' making the road appear to narrow as you approach small towns and villages. Motorists naturally tend to slow up in response.

The value of trees in land stabilisation

After the recent fires in the State of Victoria, a large number of trees were cleared from building sites. When it came to rebuilding after the fire, on at least one site, insurance companies would not insure the site because it was classed as unstable due to the risk of landslip. At least five large trees had been removed from the site along with other smaller trees and large shrubs.

There were remedies available which would satisfy criteria for insurance. One was to leave the site and allow for regeneration which would take a minimum of 10 years, reducing the use and value of the site over this period. The alternative was to use engineering techniques, such as piling to secure the site's stability, which would cost between $40 000 to $60 000 depending on the technique used and the contractors' bids, at a likely cost of about $50 000.

Given this scenario, each of the five large trees was providing a total value of $10 000 to the site (Table 7). Using the natural regeneration pe-

Table 5. Carbon lost and its value for pruning 100 mature urban tree canopies.

Approximations used	Single Tree	100 Trees
Average weight of whole tree, including above and below ground components (t)	100	
Amount of carbon sequestered in each tree (t)	13	
Amount of carbon sequestered in the canopy of each tree (t)	6.5	
Amount of carbon lost if 30% of canopy pruned from each tree (t)	1.95	195
Amount of carbon lost if 20% of canopy pruned from each tree (t)	1.30	130
Amount of carbon lost if 10% of canopy pruned from each tree (t)	0.65	65
$ value of 1 tonne of carbon	23	23
$ value of carbon pruned from 100 trees when 30% pruned	44.85	4485.00
$ value of carbon pruned from 100 trees when 20% pruned	29.90	2990.00
$ value of carbon pruned from 100 trees when 10% pruned	14.95	1495.00

Table 6. Economic value of shade for an urban street lined by 100 trees prolonging the life of bitumen.

Approximations used	Value
Estimated length of street (m)	500
Width of road surface (m)	7
Area of Bitumen road surface (m^2)	3500
50 trees on each side of the street so total number of trees	100
Shade from an individual tree canopy (m^2)	75
Area of bitumen shaded by tree canopy, estimated at 33% of total (m^2)	37.3
Total area of bitumen shaded by tree population of 100 trees (m^2)	3730
Cost ($) of resurfacing bitumen per m^2	450.00
Total $ value of extending the life of the shaded bitumen from 20 to 30 years due to the 33% shade from 100 trees	1678500

riod of 10 years, it can be estimated that each tree was contributing about $1000 per annum of function or service in securing the stability of the house site. The service could be valued over the projected life spans of the trees, which can be estimated at 50 years, which would see a $50000 benefit from five trees amortised over 50 years at $1000 per annum for $200 per annum per tree.

Value of shade in schools and other public buildings

After the 2009 wild fires in Victoria, the government moved to take action in schools located in designated bush fire regions of the State to make them more fire safe. The guidelines required the removal of trees that were closer than 30 m to school buildings.

Consequently, during the September-October holiday period of 2009, large trees were removed from several schools. One tree was removed from the middle of a large area of tarmac and several were removed from around sporting ovals and play areas where the fire risks posed by the trees were minimal. On the first hot and sunny days of late October and November, it became obvious that there was a problem. Without the trees there was no shade and during the Australian summer this posed serious health risks such as sunburn, heat stroke and skin cancer.

The remedy was simple and expensive — the installation of shade sails. There were no budgetary provisions for such costly items late in the school year. In some cases the shade provided by a single tree meant that more than one shade sail was required to compensate for the loss. However, this action has allowed the value of shade from trees in these schools to be calculated assuming the trees are at such a distance from buildings and other surfaces that there are no other compounding values (Table 8). Clearly, shade from the tree growing in the bitumen play ground may have had the added benefit of prolonging the life of the tarmac. The formula for the calculation for an individual tree is the cost of the shade sail multiplied by the number of sails required (usually one but up to four) to compensate for the shade lost.

Table 7. Economic value of trees in stabilising a suburban house site from landslip.

	Piling Replacement	Amortisation of Value from 5 trees over 50 years
Number of trees	5	5
Cost ($) of Piling	50 000.00	50 000.00
Total value ($) of 5 trees	50 000.00	1000.00 per annum
Value ($) per tree per annum	1000.00	200.00

Table 8. Economic value of urban trees in providing outdoor shade for schools and other public buildings.

	Shade sail Replacement Option
Cost ($) of shade sail (50 m^2 and support poles)	5000.00
Number of shade sails required	1
Useful life of shade Sail (Years)	10
$ value of shade provided by tree over 10 years	5000.00
$ value of shade provided by tree per annum	500.00

The value of trees in flood mitigation

Trees and public open space have a role under a changed climate in holding and absorbing water during intense rainfall events. Such a role has profound implications for the behaviour of storm water systems in cities and the role of trees in reducing localised flooding. It is not economically feasible to retrofit larger stormwater drains and alter the levels at which they enter waterways. However, trees hold rainwater on their canopies, and through transpiration significantly reduce the amount of water entering drains. Estimates suggest that trees may hold up to 40% of the rain water that impacts on them and that as little as 40% of water striking trees may enter drains (Moore 2009). This can reduce the immediate storm water load and spread the load over a longer period of time, which can reduce the need for larger stormwater pipes.

Because retrofitting larger pipes is so costly, there are trials in most major Australian cites which divert stormwater into small local retention basins or into specially designed planting pits that contain trees or other plants (Daniels 2010). Stormwater contains pollutants, particularly phosphorus and nitrogen, but when the stormwater passes into planting pits containing trees, the trees remove most of the pollutant load before it enters streams or aquifers (Denman *et al.* 2006). The extra nutrients have a fertilising effect on the trees, which grow better (Denman 2006). The removal of pollutants by trees in this way is a service that has real and calculable value.

Furthermore, along Taylor's Creek, Keilor, trees planted in a revegetation scheme in the 1980s have slowed flood water, reducing erosion and stream-side scouring. The waters are spread over a greater area, but this was available and so did not result in further or extra damage from flooding. An unexpected consequence was that litter was spread away from the creek and was left behind when the water receded. The litter can be easily and cheaply collected from the edges of the flood plain much closer to its source and with less environmental impact than it would once it entered the Maribyrnong River or Port Phillip Bay. The economic benefits of both reduced erosion and easier local litter collection could be established.

Conclusion

The economic benefits of trees are often subtle, provided over long periods of time so tend to be under-appreciated. Urban trees provide infrastructure functions and ecological services to society and have real and calculable economic value. When these values are considered, the economic algorithms and paradigms that have applied to the management of trees in urban environments will change rapidly and as a consequence the economic imperatives that apply to managing trees will change under a thorough cost/benefit analysis.

Mature trees continue to have a significant place in urban landscapes and they must be managed to ensure that they remain healthy and fulfil the full potential of their lifespans. They are assets that warrant the expenditure of resources such as labour, energy and water. Such expenditure is not wasted, as trees and urban landscapes provide far more value economically and ecologically than they use. In any comprehensive and fair calculation, urban trees and landscapes are worth more than they cost. As a truly Australian urban landscape, which values trees and recognises aridity and changed climate, emerges, it will be understood that urban trees are worth much more than they cost and that they are the keys to urban sustainability.

Acknowledgement
The author thanks Ms E Moore, linguist, for her suggestions for improving the manuscript.

References

Anon (2010) Final report, 2009 Victorian Bushfires Royal Commission. Final Report. (Victorian Government: Melbourne)
Daniels CB and Tait CJ (eds) (2005) *Adelaide - Nature of a city: the ecology of a dynamic city from 1836 to 2036.* (BioCity: Centre for Urban Habitats: Adelaide)
Daniels CB (ed) (2010) *Adelaide: Water of a City.* (Wakefield Press: Adelaide)
Dedman R (2010) Alternative water supplies for health and wellbeing. (Victorian Department of Health: Melbourne)
Denman L, Breen PF and May PB (2006) An investigation of the potential to use street trees and their root zone soils to remove nitrogen from urban stormwater. *Australian Journal of Water Resources* **10**, 303–311.
Denman L (2006) Are street trees and their soils an effective stormwater treatment measure? In *Proceedings of the Seventh National Street Tree Symposium*, pp.1–10. Eds D Lawry, DC Christophel and S Smith (TREENET/University of Adelaide: Adelaide)
Fisher P (2007) Why we need the urban forest. *Urban Magazine* July 2007.
Garnaut R (2011) *The Garnaut Review 2011: Australia in the Global Response to Climate Change.* (Cambridge University Press: Port Melbourne)
Lister T (2010) Can't see the speedo for the trees. *The Times*, 16 August 2010.
McPherson EG (2007) Benefit based tree evaluation. *Journal of Arboriculture & Urban Forestry* **33**, 1–11.
McPherson EG and Muchnick J (2005) Effects of street tree shade on asphalt concrete pavement performance. *Journal of Arboriculture* **31**, 303–310.
Moore GM (1997) Benefits of street trees, *Arbor Age* 3–8
Moore GM (2006) Urban trees and the global greenhouse. In *Proceedings of the Seventh National Street Tree Symposium*, pp 23-28. Eds D Lawry, DC Christophel and S Smith (TREENET/University of Adelaide: Adelaide)
Moore GM (2009) People, Trees, Landscapes and Climate Change. In *Climate Change On for Young and Old*, pp 132–149. Ed H Sykes. (Future Leaders: Melbourne)
Mullaly J (2000) Aerial Photographic Analysis of the Urban Forest. (Unpublished Honours Thesis, Burnley College, University of Melbourne)
Tapper N (2010) How Trees save lives: the role of a well watered landscape in liveable cities. In *Proceedings of the Eleventh National Street Tree Symposium*, pp 25–33. Eds D Lawry and B Merrett. University of Adelaide/Waite Arboretum, Adelaide.
Tarran J (2006) Trees, urban ecology and community health. In *Proceedings of the Seventh National Street Tree Symposium*, pp. 58–71. Eds D Lawry, DC Christophel and S Smith. (TREENET/University of Adelaide)

Received 7 June 2012; accepted 2 August 2012

One Hundred Years Ago

VICTORIAN STATE FORESTS.—The recently issued report of the Department of State Forests, Victoria, for the year ending 30th June last, contains some interesting information. The Conservator of Forests says the output of sawn hardwood for the year was about 53,000,000 feet, of which the Warburton, Toolangi, and Yea division contributed nearly 30,000,000, while the Otway and Heytesbury mills cut 9,300,000 feet. The production of red gum by the mills along the Murray amounted to 3,930,000 feet. A gratifying record is given of various works carried out for the improvement of the forests, and of the work done in the nurseries and plantations, some 2,750,000 seedlings having been put out. In a report on the giant trees of Victoria, Mr. A. D. Hardy, F.L.S., summarizes such information as has been published from time to time regarding the tall trees of the State, from which it appears that Baron von Mueller's statement that he had measured trees of 420 feet and 480 feet on the Blacks' Spur is questioned. A definite record exists of a prostrate tree in the Otway Forest measuring 329 feet to where the top was broken off, at which point the stem diameter was still 10 inches, the general conclusion being that there are many trees still existing of 300 feet and slightly over. As regards girth, 64 feet at 8 feet from the ground, also an Otway Forest specimen, seems to be the record. These figures closely approximate those of the Redwoods of California, definite measurements of which also seem difficult to obtain.

From *The Victorian Naturalist* **XXVIII**, p. 195, February 8, 1912